SOME PROBLEMS IN SCIENCE AND MUSIC

Exploration in Possibilities

B. C. Deva

The first and the essential problem is the recognition of the fact that there can be a scientific investigation of music almaterial. So far musicology has been historical and meant, most often, quotations from old texts; all the while it is forgotten that the finest of these texts themselves were scientific treatises in music. The theory of *sruti*, *chatussarana*, lengths of strings on the *veena*, the fourfold classification of instruments — all these are in truth of profound scientific content. However, that contemporary thinking and ways of life have affected — affected deeply — our music and musicology, only a few people are aware and if we are to produce a creative musicology, this awareness of contemporaneity and scientific attitude is indispensable.

There seems to be a dichotomy between 'science' and 'musicology', and an accepted ignorance of the fact that a rational and specific thinking is the foundation of the philosophy of science and musicology; and, of course, there is the unknowable 'intuition'. This unitary approach however, is expressed again and again in our musicology in the theory of *sruti*, the theory of *rasa*, theory of time and *tala;* but, by some unknown logic, so long as one uses these Sanskrit words, it is said to be musicology and the moment one talks of these very same ideas as difference limen in pitch, the psychology of musical affect, and the dynamics of temporal division, it is dubbed as 'science' to be kept away from 'musicology'. A release from such a burden of traditional habit is, therefore, very necessary, and an examination of musical material in terms of current scientific methods imperative, as a continuation of traditional musicology.

This interdisciplinary enquiry into music and its nature can be multifaceted, all facets mutually overlapping and interpenetrating. For instance, there is no physical (objective) phenomenon which does not have a subjective counterpart — at some level or the other. As Benjamin Whorf has so elegantly put it, there is an interpenetrating progression from the physicochemical undulation to the *mantric* level; indeed, musical experience is a continuum and no one knows where the physical ends and the mental begins.

An attempt, therefore, will be made here to discuss certain problems which merit deep enquiry. It facilitates discussion if we here adopt the language of modern theories of communication. This, *ipso facto*, presumes that musical activity is a form of communication. That it is so, there need be no doubt. What is necessary is to enquire into the nature of this communication. There are three stages in any communication; (a) encoding, (b) message and (c) decoding. Most generally put, encoding is the formation and sending of the message; the message itself (actual music) is the carrier of information; and decoding is the receipt, perception and 'understanding' of music. (Fig. 1).

(a) *Encoding:* The state of the musician is the problem which is to be studied here. Why is music produced at all? This is one of the most baffling questions and no satisfactory answer to it has been found yet. Depth psychology can show us the way in one direction: the unconscious sources in the human mind and perhaps to animal psychology. In the West there have been many hypotheses and theories from Aristotle and Plato to Santayana, from Darwin and Spencer to Revesz and Sachs. There is also the attempt — by Ehrenzweig, for instance — to trace the wellsprings to a basic undifferentiated vocal material from which have sprung speech and music: the former for conscious articulation and the latter for peripheral non - (un) conscious articulation.

At the other end of the spectrum, as it were, is the *mantra yoga* and *nadopasana*. All vibration — *nada* — as human beings know it, is taken to be the result of the movement of *prana* through the six *chakra*-s. This again requires careful investigation and is not to be dismissed as fancy and mystery. Here obviously is an area where the science of *yoga* can contribute and help.

The motivations, the mental adjustments, the physiological syndromes of the musician (and we have to bear in mind that the musician is at once a listener also) are aspects which lend themselves to investigation.

(b) *The message:* As an axiom we start with the statement that "music is a form of communication". This is a very obvious pronouncement. But a lack of such a definition has been the cause of much loose

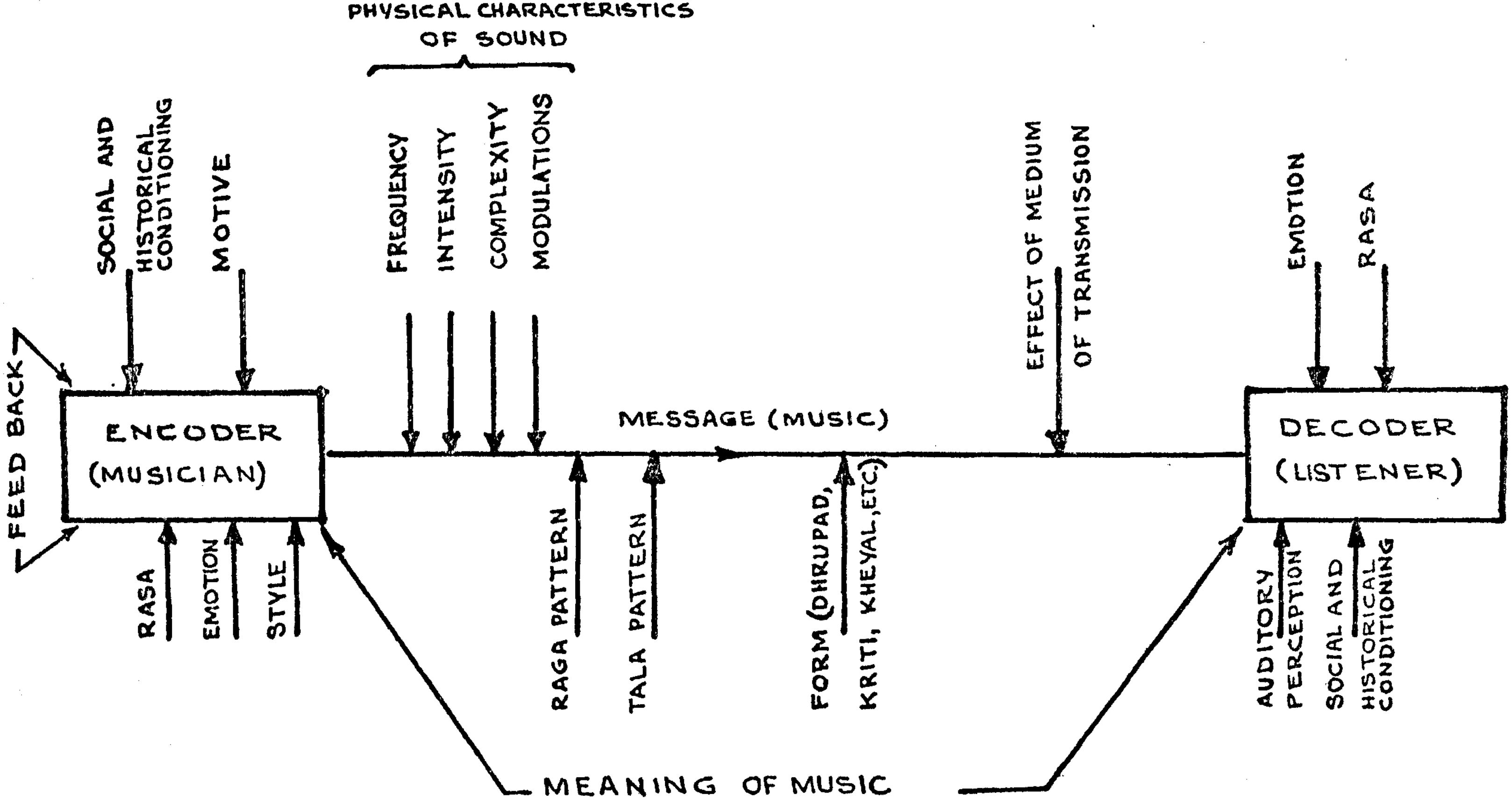

Fig. 1. Music as a communicative process.

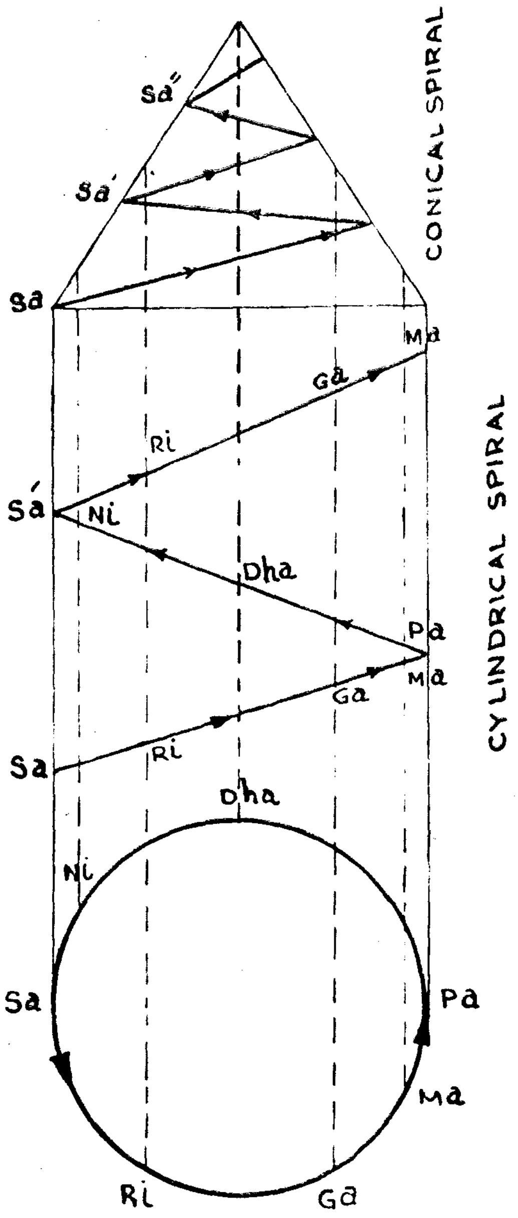

Fig. 2. Musical Pitch as a cycle and spirals.

thinking; and once we accept this, all mathematics of communication — *mutatis mutandis* — can be applied to musical analysis.

The problems one can study are indeed enormous in extent and depth. One could start, for instance, with the characteristics of instruments — their tonal qualities, mechanisms and so on. Much work can be done on the study of voice quality and voice production. Public address systems, radio and gramaphone — their effects on the propagation of music can open up new vistas; computerization of Indian music has already come to be. However, I would like to discuss here two areas; not because they are the only ones discussable but because they are the most discussed—(i) musical scale and (ii) *raga* form.

(i) We shall define a *musical scale as the ordering of pitches in an increasing or decreasing sequence within an octave.* While this appears simple, the internal ordering of pitch elements has posed extremely complicated problems, because it involves two 'directions' of perception. One is the fact of linear progression and the other is the repetitive or circular nature of *musical* pitch-relation. What we may call the linear progression is the increase in pitch associated (mainly, but not solely) with increase in the frequency; the change in frequency (and other parameters) changes the pitch in an upward or a downward direction. Like most physiological phenomena, the change is *logarithmic.* On the other hand, there is the sense of octave or *sthayi* (*mandra*, *madhya*, *tara*, etc.). For the nonce, taking a seven-tone scale as a standard, every eighth note is a 'repetition' of the first; somehow, it is 'like' the first note and yet different (it is 'higher' or 'lower'). That is, the phenomenon of octave is cyclic. (It is possible to study this in terms of the dynamics of the inner-ear; but we shall not extend our discussions so far at this stage). A similar bi-parametric movement takes place in *tala* also; the stream of time is linear, but the *avarta* is cyclic and is superimposed on it. Another instance is the relation of the week, the month and the seasons (all repetitive) to time. The periodic table of elements is one more instance of such arrangement. The perception of colour, however, is linear; that is, while colours change with the frequency, there is no repetition of the spectrum in relation to the chromatic sensation.

Here then are two movements which are simultaneous: rather, one movement with two characteristics. The most elegant — and, perhaps, the only — way to represent this twofold quality is by a spiral. For, it, at once, moves forward and has points of similarity though not of identity. (Fig. 2). Consider the points *Sa*, *Ri*, *Ga*...... As we move along the spiral, we are going 'up' and every point is 'higher' than the preceding one. But take, for instance, the case of *Sa*'; it is 'higher' than all the preceding notes, yet 'viewed' along the vertical axis it is the 'same' as *Sa*.[1]

But a spiral is infinite, endless; this is an experience which the human mind seems to be constitutionally incapable of. If it does get into this state, it seems to be 'death'[2]. The mind and body of man have to 'live' in time-space of a finite nature. Therefore, there should be a closure. In effect, the spiral has to be changed into a circle. This very fundamental process is the basis of scales of all musical systems, each making the adjustment in its own way. The Pythagorean and Chinese method is of the cycle of fifths. The cycle never ending on *Sa*, introduced the comma. The Indian system does the adjustment by *shadja-panchama, shadja-madhyama* (and *shadja-gandhara*) *bhava*. I am of the opinion that the gap which has to be bridged to change the spiral into a circle is the *sruti* (note the significance of the world and its meaning); I may draw the attention of the reader to spiral nature of *kundalini*, of *ida* and *pingala;* the gap in the spiral is the *brahmarandhra*.[3]

In the process of this conversion, it is necessary to take recourse to many approximations, which we are apt to forget. This approximation is also implied in the relation of number of *sruti*-s to the number of notes — 22 : 7, a very significant pointer to *pi*, an irrational number. Again, this very irrationality and the necessity of approximation make it impossible to get a scale wherein there is a *complete* relation of fifths (*shadja-panchama bhava*) between the two tetrachords; to perceive this completeness it becomes necessary to have the three *grama*-s which complement one another to give all probable fifths and fourths.

It is also a well-known fact that physiological and psychological experience are logarithmic to a large extent, a fact expressed by the Webner-Fetchner law, which can be generally stated thus: "*Two stimulii of equal intensity can only evoke a just perceptible increase in sensation if they bear a constant ratio to each other*"[4]. Arithmetically put, the ratio of the change in sensation (dI) to the sensation (I) is constant — i.e. $dI/I = k$. While more recent work has not fully confirmed this hypothesis, musical intervals, by and large, obey this law. Musically expressed, the relation of *Sa - Ri* = *Sa' - Ri'* = *Sa'' - Ri''* and so on. It is because of this that *sruti*-s are *additive* and hence, again, approximations[5].

The best known Indian experiments in this field are by Bharata (*sarana chatusthaya*), Sarngadeva, (his definition of *sruti*, as just noticeable difference in pitch), Ahobala (lengths of strings); more recently Deval conducted experiments with a sonometer, with the help of Ustad Abdul Karim Khan. But with newer mathematics, and newer equipment, experimental work on *sruti* is an absolute necessity. While this is one of the most baffling and complicated problems, it is an area where the least experimental work has been done. We do not know, by controlled experiments, which *sruti* occurs in which *raga*; neither do we know the extent of pitch variation of a note in a *raga*; our ignorance about the nature of *gamaka* and its measure is profound. Yet we do not hesitate to write down and discuss the most complicated ratios — even try to prove them by singing and playing — as if they were verified facts!

(ii) Another aspect of music, as message, is its ordering. What is the structure of a *raga* and what are the interrelations of *raga*-s in terms of these forms? We have been classifying *raga*-s and *jati-s*, under *mela*-s and *murcchana*-s. But so far there has not been a systematic probing into the structure of a *raga*, except in qualitative terms as *raga-anga*, *pakad*, *sanchara*, etc.

We have to press into service here the methods of cybernetics and communication theories. The present author had earlier examined some methods, particularly the entropy values of *raga*-s, as also the internal ordering of notes in similar *raga*-s.[6] The measures used for defining *raga* forms were: entropy, relative entropy, redundancy and rank correlation. The basic assumptions in all this is that a *raga* is a Markoff process and a *stochastic* process. Taking this as correct, every *raga* has not only static notes in terms of *bahutva*, and *alpatva* but the tonal movement — the transition matrix. It should be possible to draw the curve of time-pitch and extract the essential leaving out the random. The present writer has used autocorrelation methods for this.[6] (What is known as the 'run method' can also be tried). Once we know the form of a *raga*, it gives us a statistical definition of the stimulus or message. It also enables us to computerise our music an experiment which has begun. One other use of this method is that it can be employed in the comparative study of styles of composers (*Vaggeya kara*-s). Again it is a good tool to the historian to study the changes in *raga structure.*

(c) *Decoding:* This is the process of reception and perception, and reaction to the stimulus (message). It is a totality of sensation, nervous conduction, conscious and non-conscious perception and finally the emotional response to music.

There are two very important ideas that I would like to put forward here:

(i) The *commonness* between the encoder and the decoder is the *meaning*. In the widest sense, all vibrations — messages — sent out by the encoder (musician) and received by the decoder (listener) are *meaningful.* For instance, all the physical undulations sent out by the singer and reaching the listener have meaning at the physico-physiological level. This is the stage of maximum information. From there on there is a gradation of abstraction, each successive stage being more and more centralised and specific. From the physical one can go on to the physiological, peripheral nervous, central nervous, unconscious and conscious degrees of perception. One can then touch the aesthetic state or *rasanubhuti.*

So far, musicological studies and musical acoustics have limited themselves to central perception and intelligibility levels. These discussions limit themselves to what are called 'notes', *alankara*-s, *tala*-s and so on which are consciously defined quantas. But, as just pointed out, there are areas of perception which are much wider in extent in which no research has been conducted. To give examples: electro-galvanic and electro-electroencephalic responses could very easily provide interesting clues to peripheral perception and response. Again, questions of tonal masking (physicological and psychological), perception of *gamaka* and so on are entrancing areas for research.[7]

(ii) The other point I would like to touch upon is the study of emotional response to *raga-s.* It is easier to restrict ourselves *only for the present*, to empirical research, without entering into the nature of aesthetic experience and *rasa.* Most of the literature we find on the emotional values of *raga*-s are highly speculative and personal. What we require is a systematic work on the 'meaning' of music. To the best of my knowledge there has been only one such study[8]. To relate the results of controlled experiments to traditional mood association of *raga*-s and *ragamala* pictures, is of great urgency. Further, what, for instance, can be the use of our music in drama? Can we find a workable relation to the nine *rasa*-s in drama to music and how best can dramatists use this material.

Finally, one ends with the realisation that the actual materials of music and their behaviour have not been studied to the extent they deserve. For this, it is absolutely necessary not to draw lines of demarcation and create pigeon holes of 'knowledge', if musicology is to be creative.

Notes and References

1. cf. the two-component theory of G. Revesz, in his, *Introduction to the Psychology of Music*, p. 67 (Longmans, 1953).
2. Deva, B. C. *Psychoacoustics of Music and Speech*, p. 203. ft. nt. 33 (Music Academy, Madras 1967), for a discussion of symbolism and death.
3. Arthur Avalon, *The Serpent Power* (Ganesh & Co., 1953).
4. Revesz, *op. cit.* p. 8.
5. For a further discussion of *sruti*, see Deva, B.C., *op. cit.* Ch. 8.
6. Vide, Deva, *op. cit.*, Ch. 12, and B. C. Deva and P. S. Nair. Forms in Music, *Sangeet Natak*, No. 2, April 1966.
7. Vide. Deva, *op. cit.* Ch. 9.
8. B. C. Deva and K. G. Virmani, Meaning of Music, *Sangeet Natak*, No. 10, October-December, 1968.